US006747218B2

(12) **United States Patent**
Huseman et al.

(10) **Patent No.: US 6,747,218 B2**
(45) **Date of Patent: Jun. 8, 2004**

(54) **ELECTROSURGICAL HAPTIC SWITCH INCLUDING SNAP DOME AND PRINTED CIRCUIT STEPPED CONTACT ARRAY**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 66 days.

(21) Appl. No.: **10/251,606**

(22) Filed: **Sep. 20, 2002**

(65) **Prior Publication Data**

US 2004/0055860 A1 Mar. 25, 2004

(51) **Int. Cl.**^{7} **A61B 18/00**; H01H 9/00; H01H 13/64; H01H 13/715

(52) **U.S. Cl.** .... **200/1 B**; 200/4; 200/5 R; 200/5 A; 200/52 R; 200/406; 200/292

(58) **Field of Search** .... 200/5 A, 512.517, 200/406, 407, 302.1–302.3, 275, 292, 1 B, 4, 5 R, 1 R; 606/41–48

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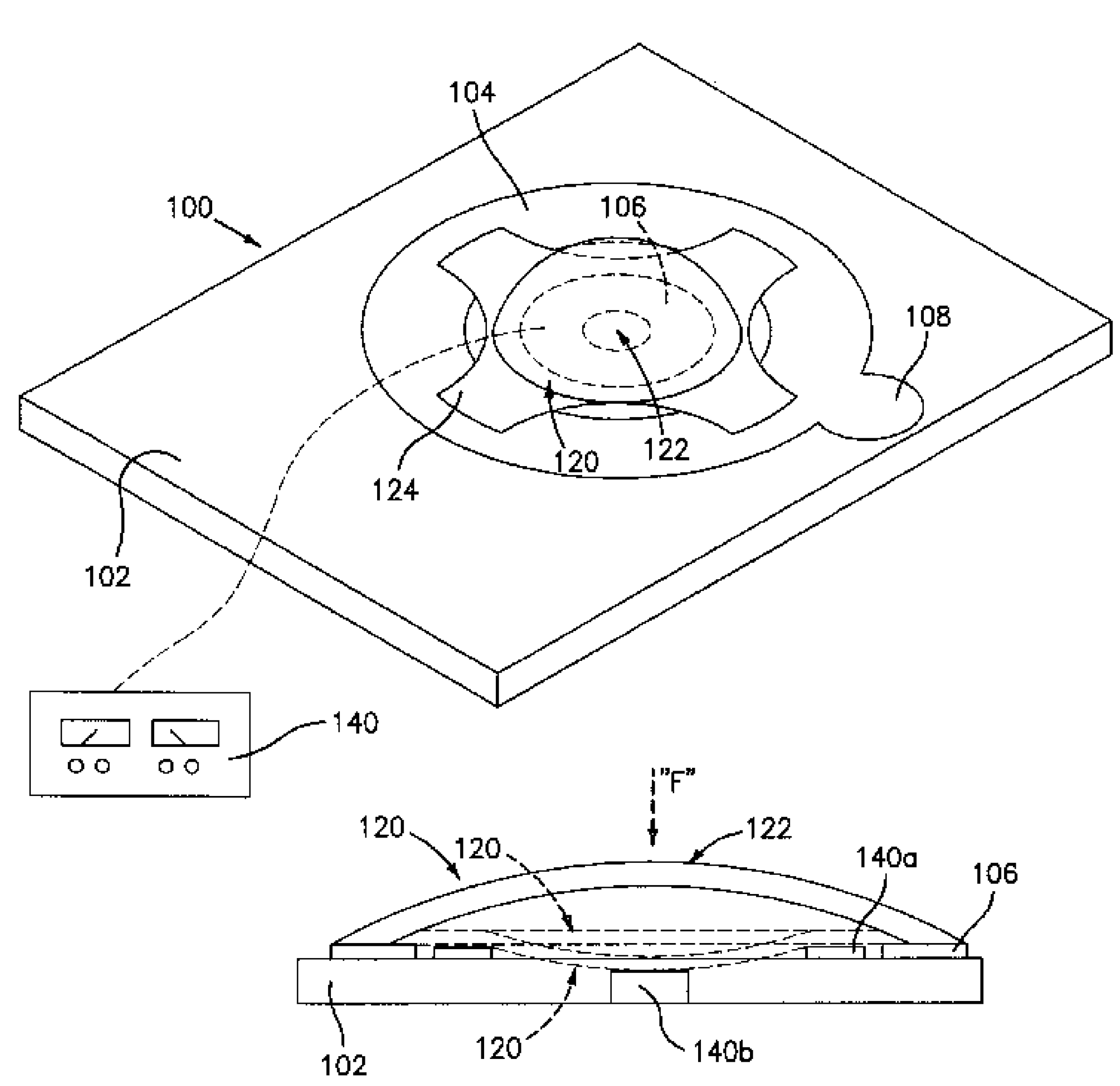
(57) **ABSTRACT**

The present disclosure relates to tactile switch assemblies having stepped printed circuit boards for use with snap-domes in surgical instruments. In accordance with one aspect of the present disclosure a tactile switch assembly for use with a surgical instrument includes a substrate, an inner terminal disposed on an upper surface of the substrate and having a first height, an outer terminal disposed on the upper surface of the substrate and substantially surrounding the inner terminal and having a second height which is greater than the height of the inner terminal and a snap-dome secured to the substrate and having a periphery engaged to and in electrical communication with the outer terminal. The snap-dome is depressible through a range wherein, upon inversion of the snap-dome, an apex of the snap dome electrically connect the inner and outer terminals.

9 Claims, 5 Drawing Sheets



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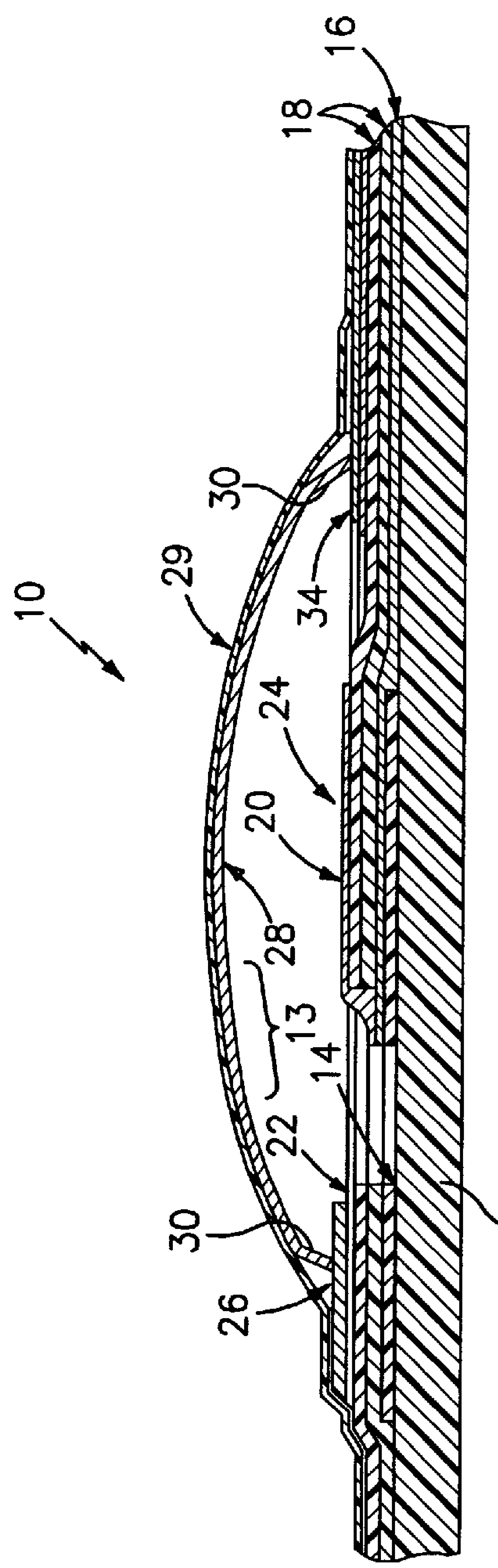

FIG. 1A
(PRIOR ART)

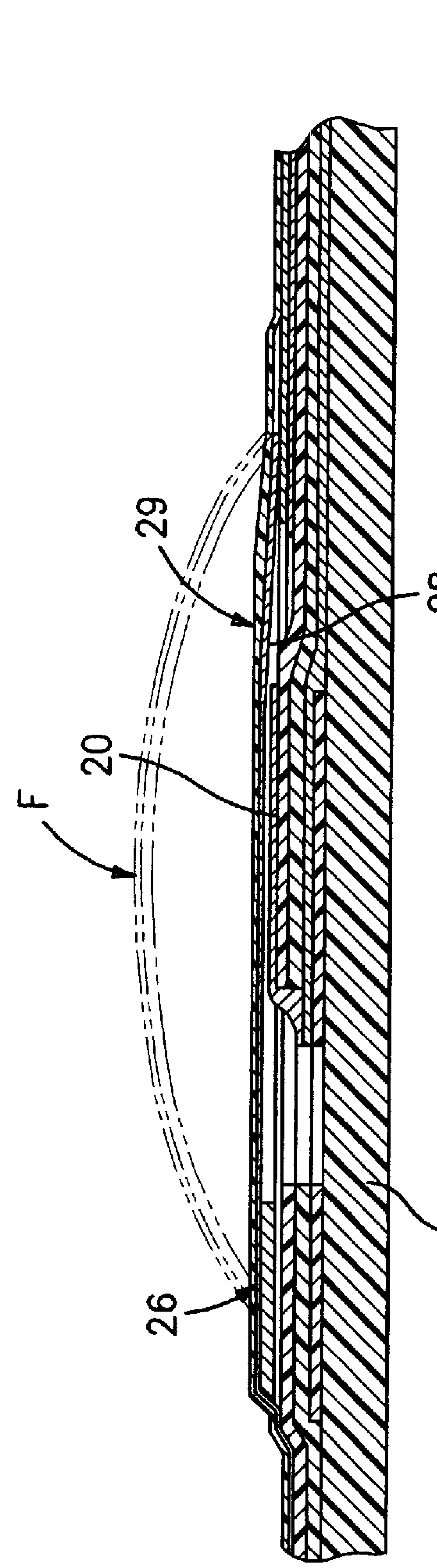

FIG. 1B
(PRIOR ART)

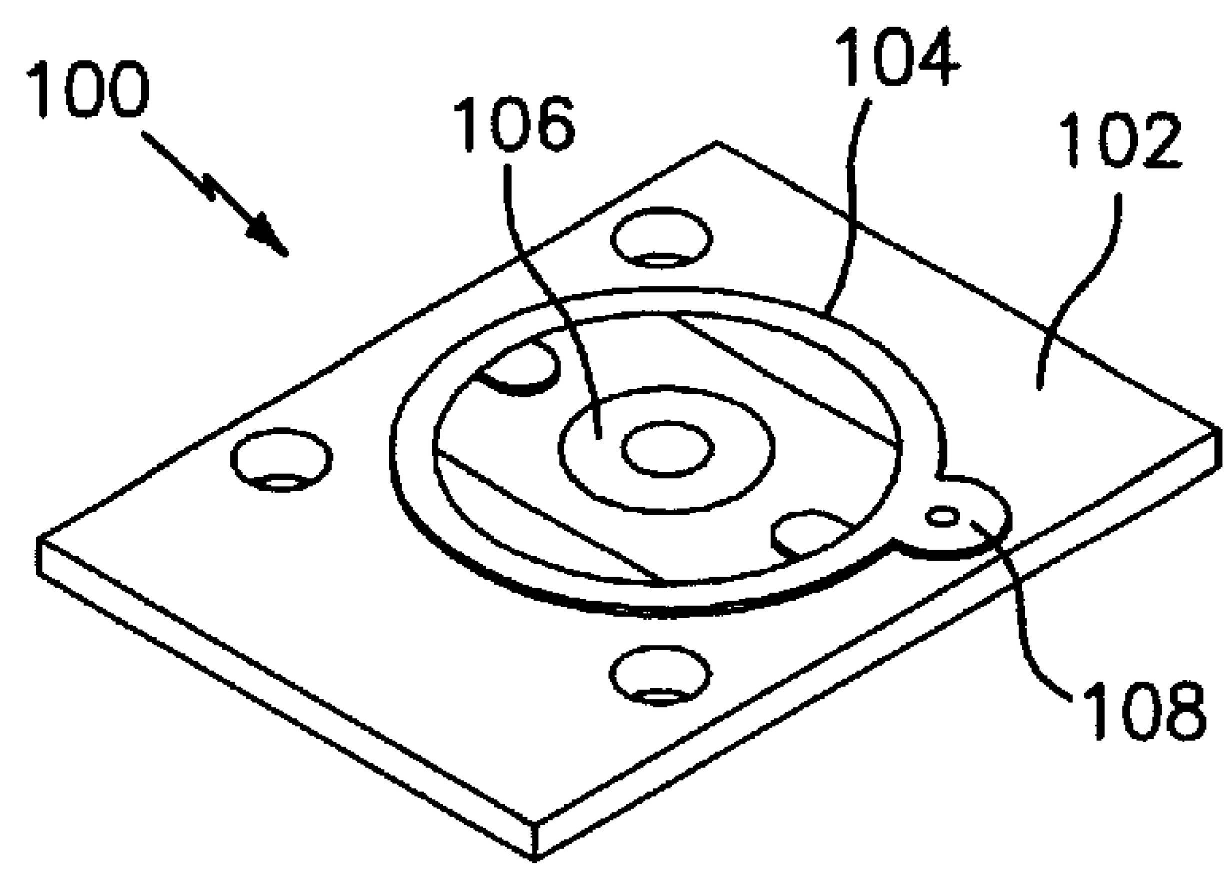

FIG. 2

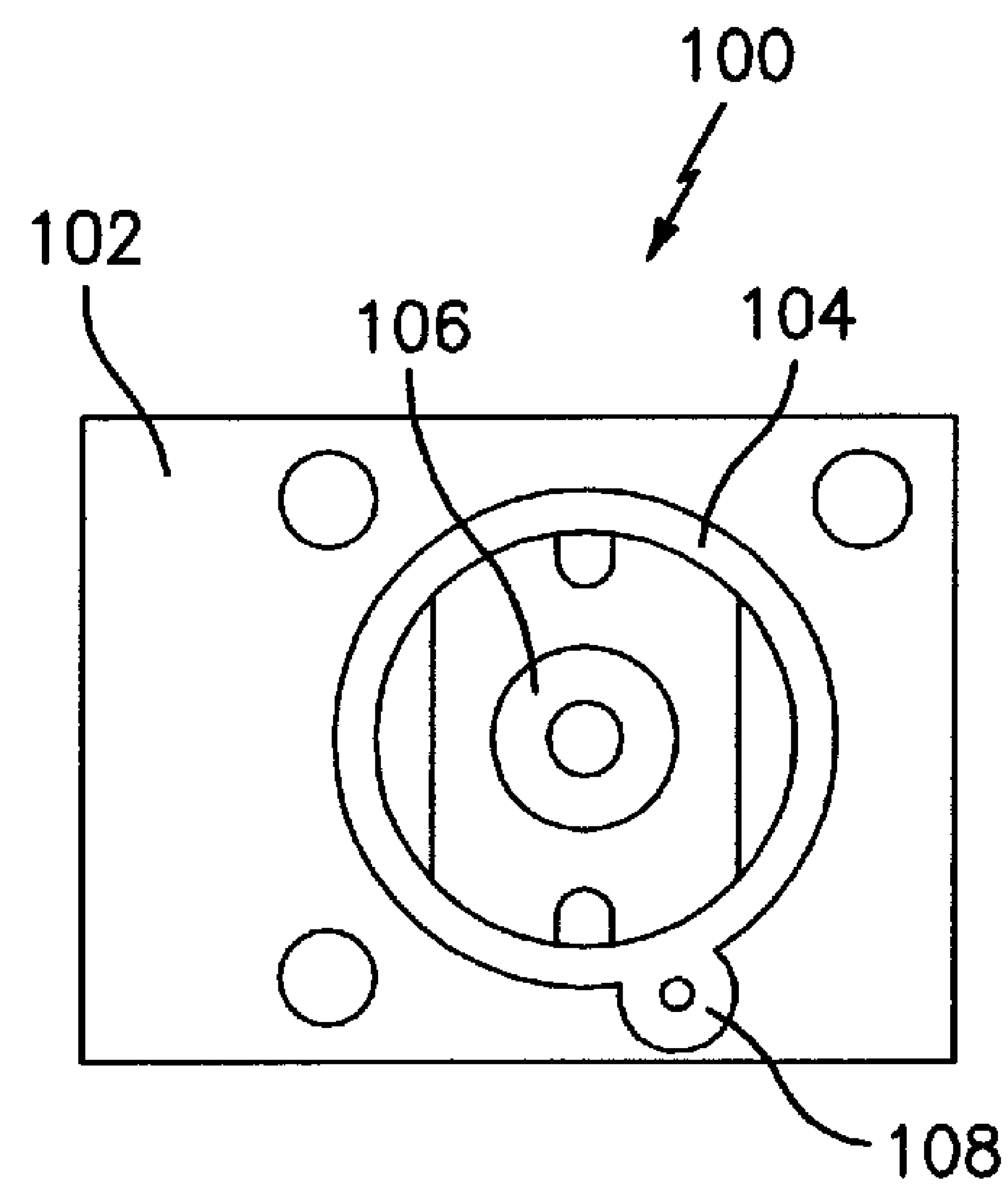

FIG. 3

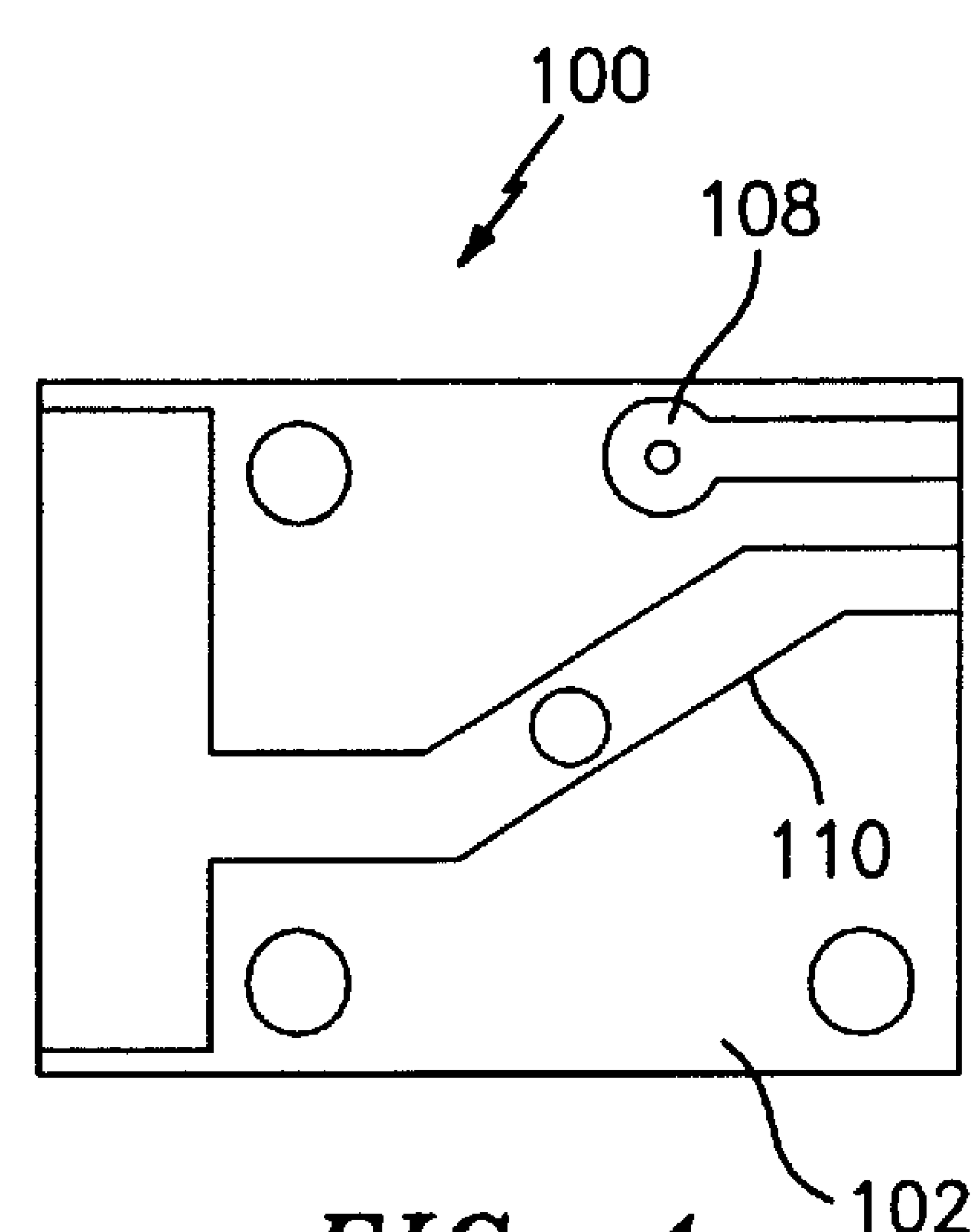

FIG. 4

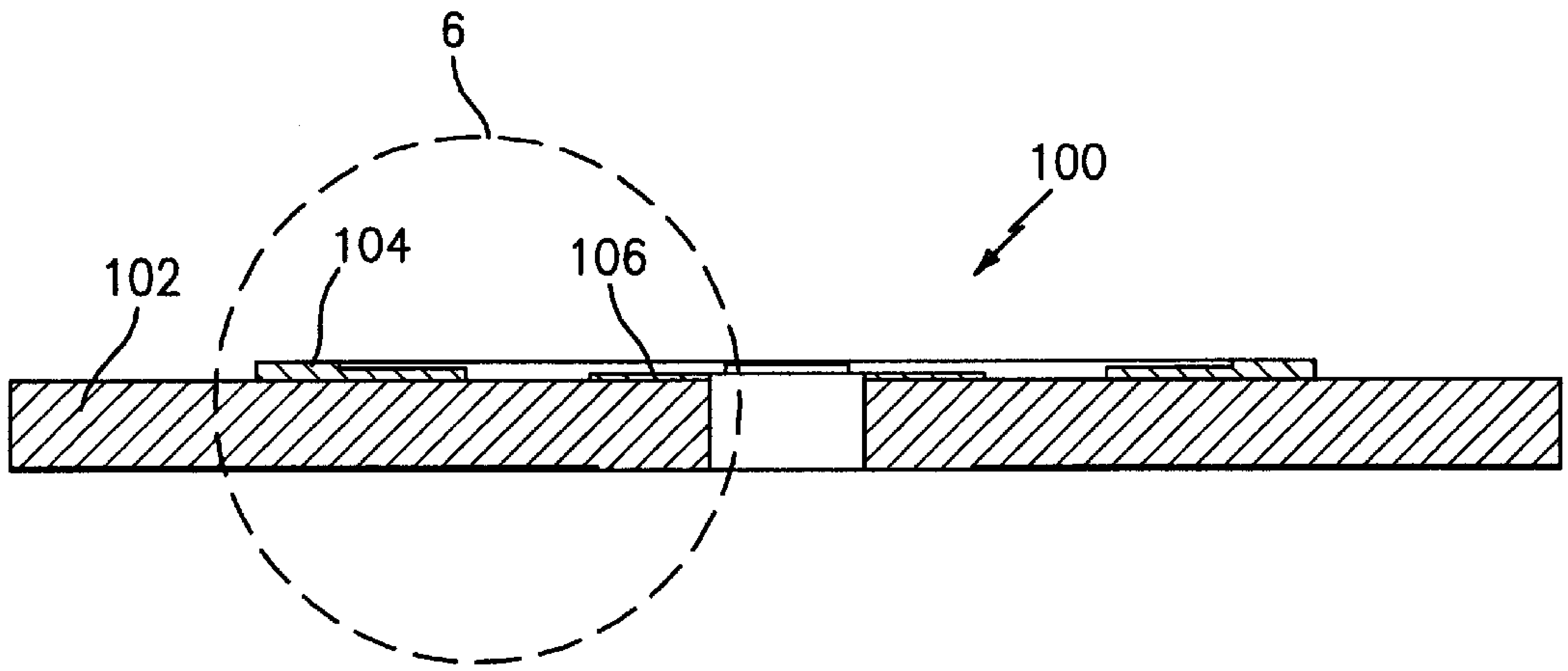

FIG. 5

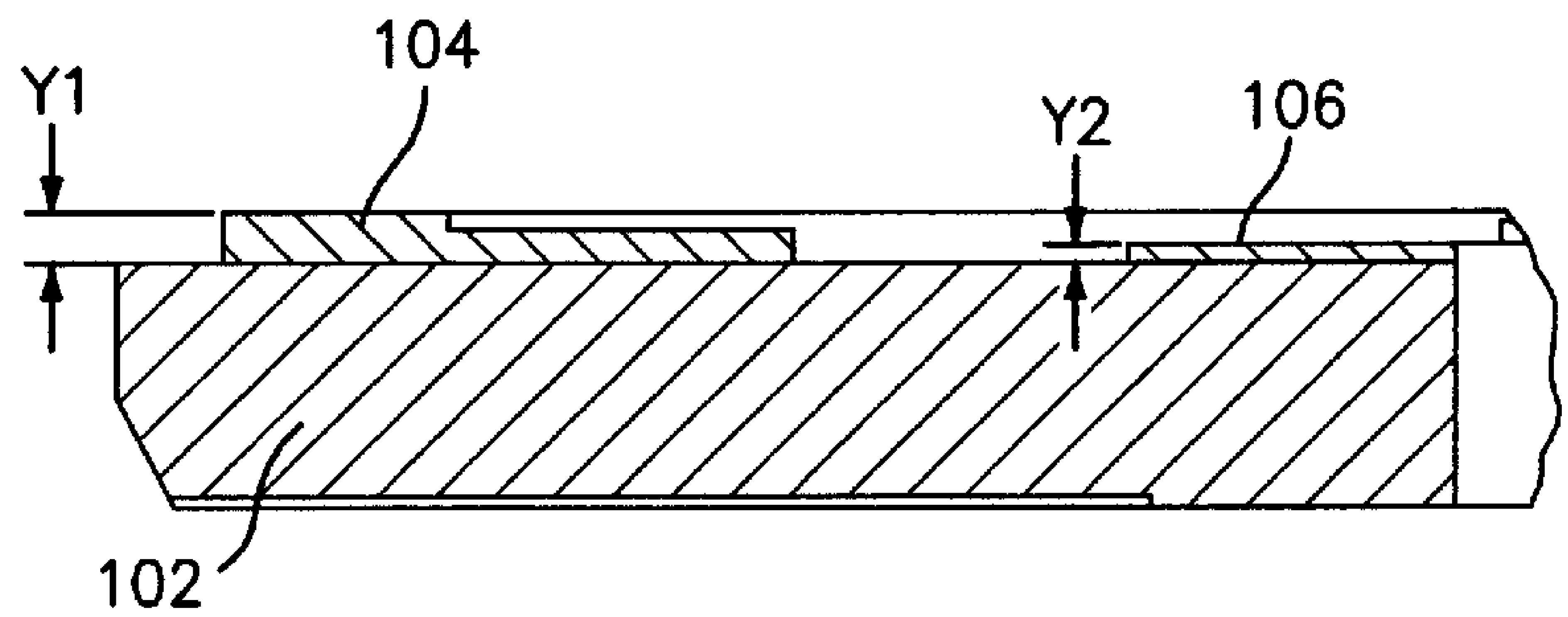

FIG. 6

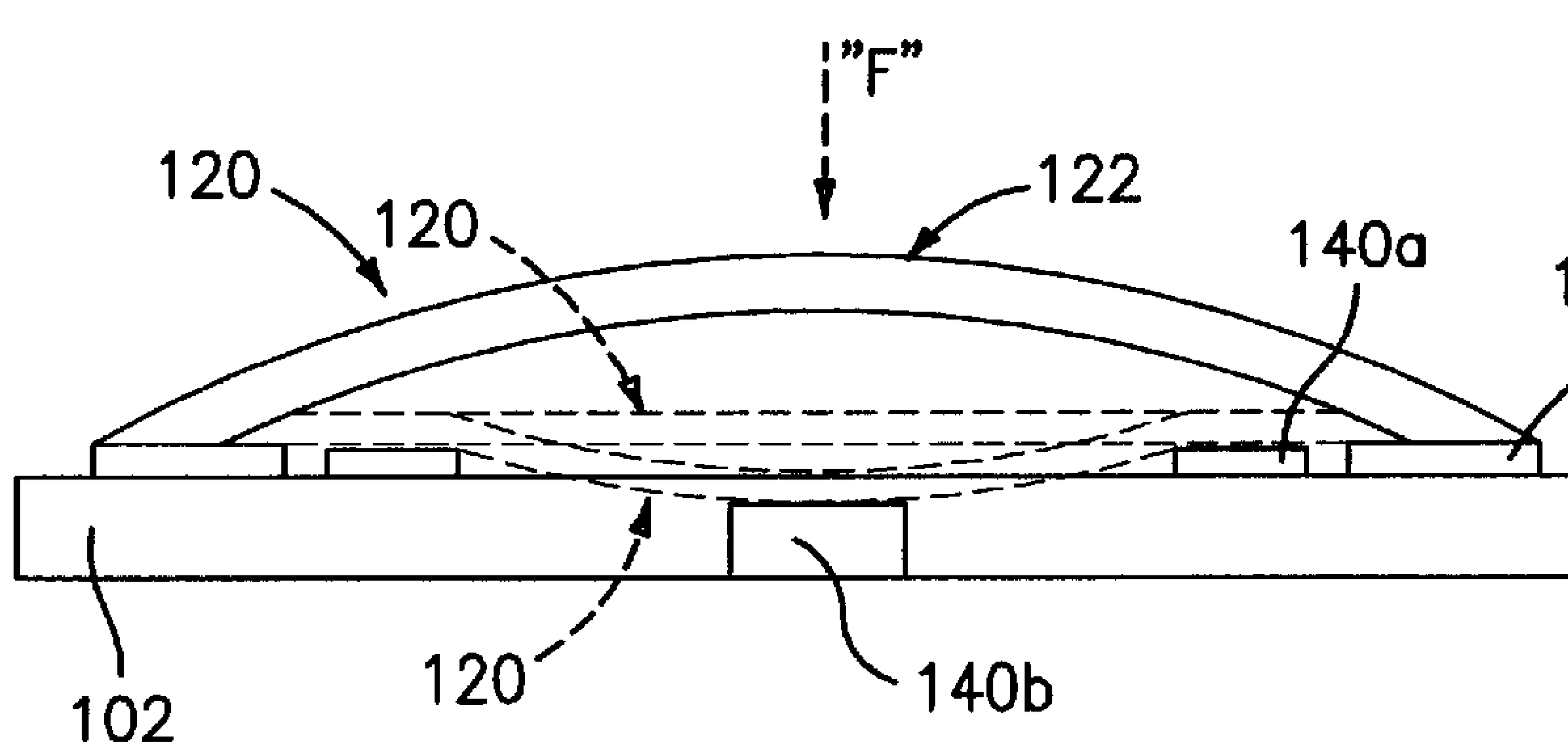

FIG. 9

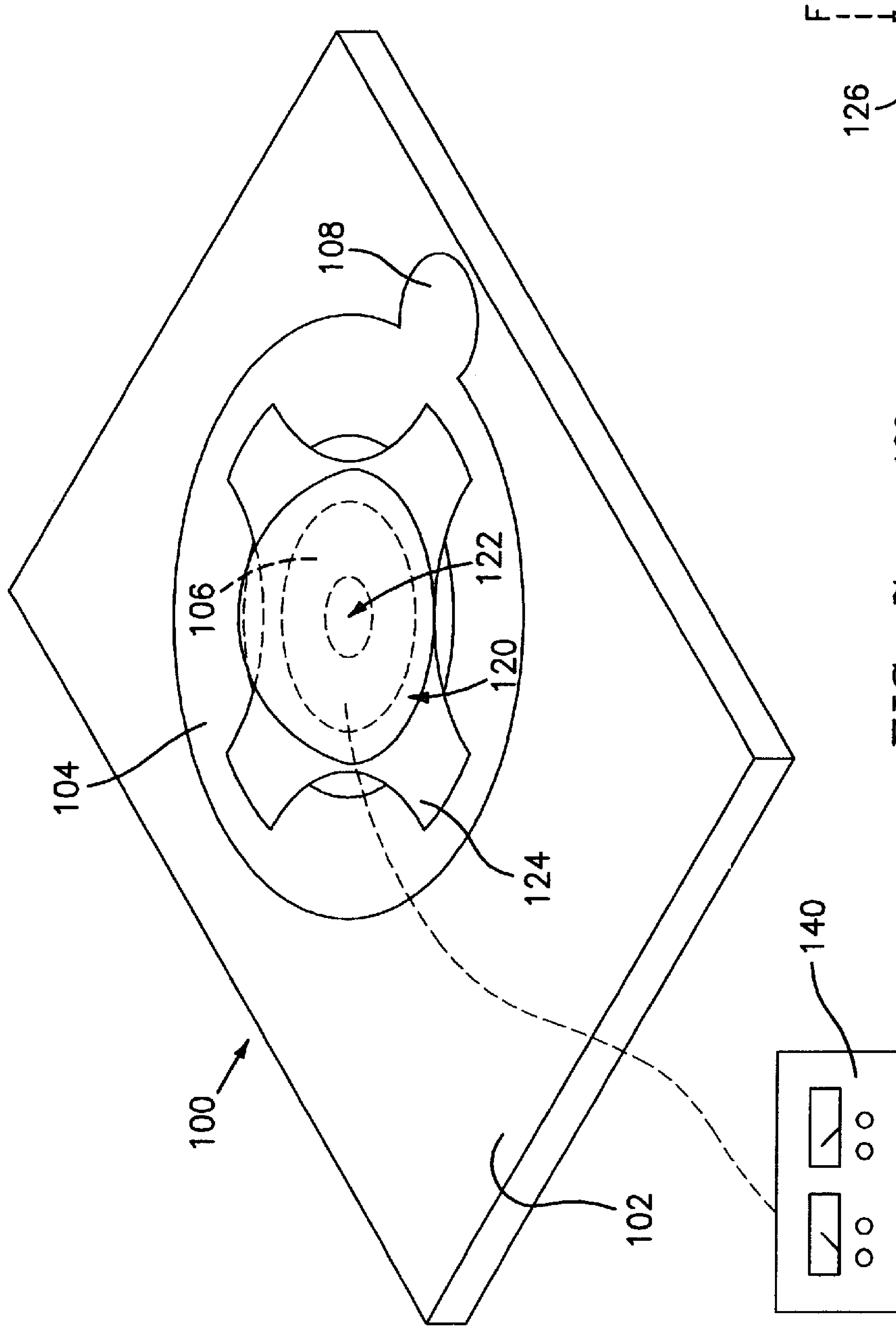

FIG. 7

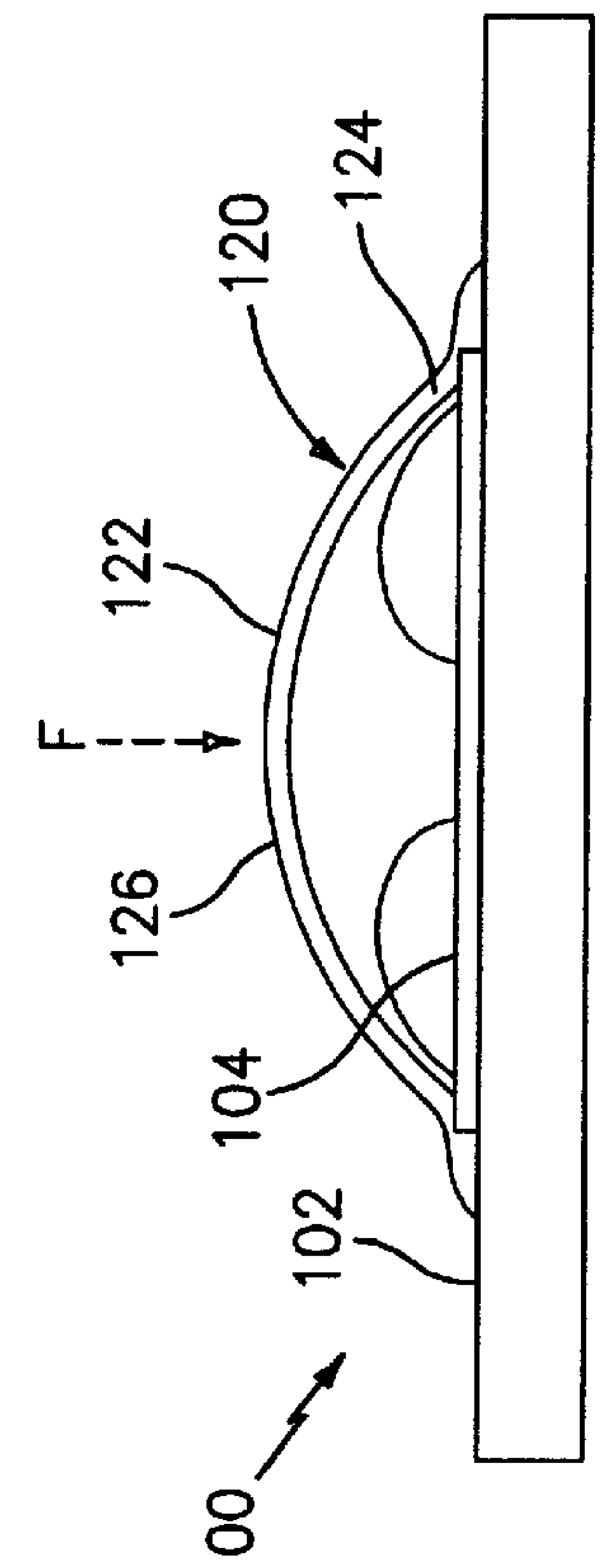

FIG. 8

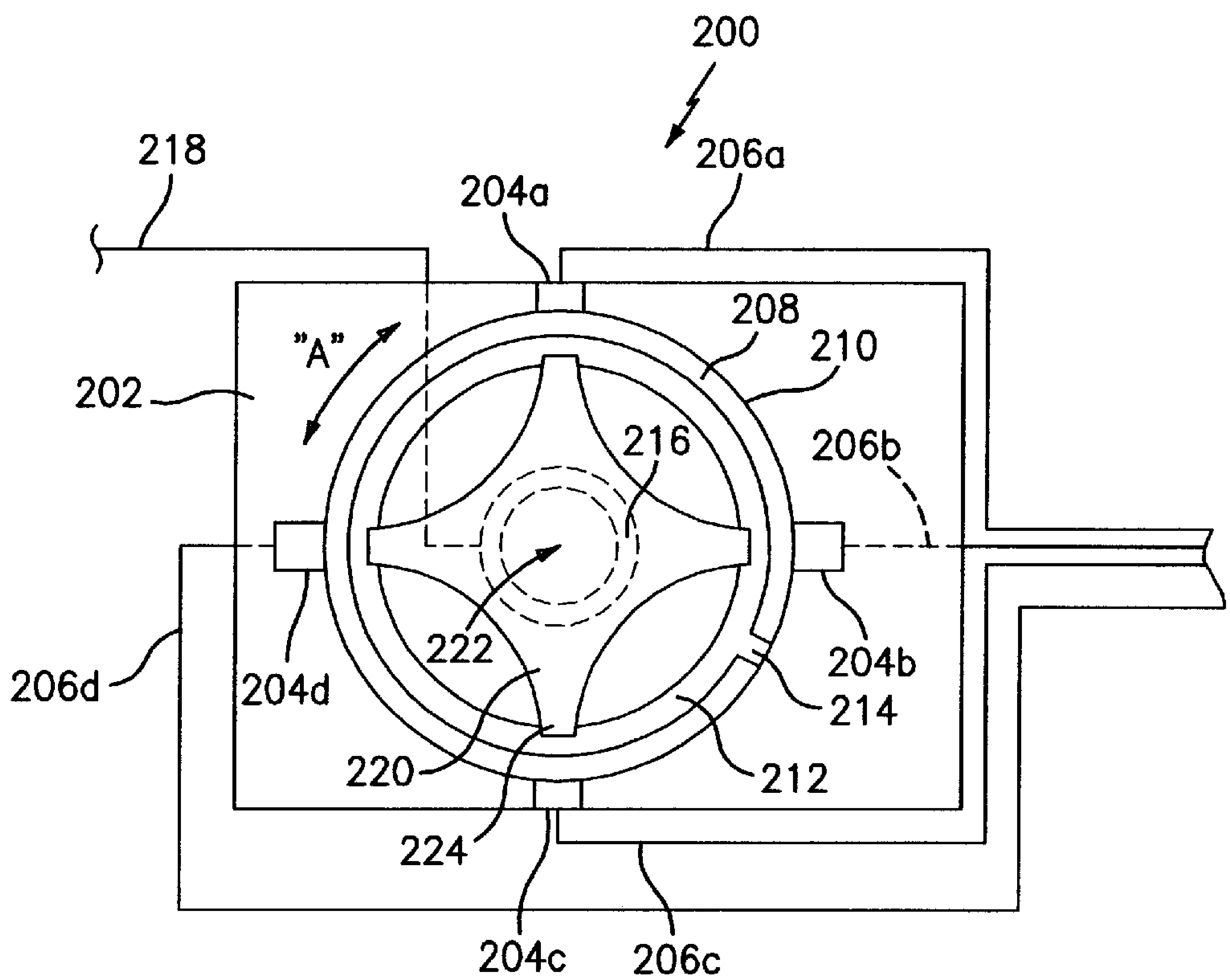
200
218
206a
204a
208
210
"A"
202
216
206b
222
206d
204d
204b
214
220
212
224
204c
206c

FIG. 10

ELECTROSURGICAL HAPTIC SWITCH INCLUDING SNAP DOME AND PRINTED CIRCUIT STEPPED CONTACT ARRAY

BACKGROUND

1. Technical Field

The present disclosure relates generally to printed circuit boards and, more particularly, to a stepped printed circuit board for use with snap-domes in medical devices.

2. Background of Related Art

A wide variety of electrosurgical devices have been developed in the past for use by surgeons during various operations. For example, pulse-like electrosurgical devices have been used for a variety of operations for cauterizing and coagulating tissue during surgery. In addition, apparatii using high frequency or RF pulses (i.e., radio frequency pulses) have been employed for cutting tissue utilizing exposed electrodes having various geometries, e.g., loop wires, needle electrodes, ball-like electrodes, blade-like electrodes and the like. Early electrosurgical devices generally required actuation via foot switches or manual switches which were remotely located relative to the surgical site often requiring the surgeon to seek assistance during the operation.

In order to provide the surgeon with more direct control of the instrument, devices have been developed enabling electrosurgical mode selection and electrosurgical activation of the signals supplied to the electrode (for example, a continuous A.C. signal for cutting or a pulse A.C. signal for coagulating), switches are mounted on the instrument body which allow the surgeon to selectively activate and control the energy emission from the electrosurgical generator. In this manner, the switches permit the surgeon to select varying modes of operation of the same instrument during surgery. The switches are typically sealed to prevent fluids or tissue from contaminating or affecting the interior electronics of the instrument to assure proper operation of concomitant precision and safety during use.

A typical switch for electrosurgical pencil includes a tactile or audible feedback membrane switch, wherein one or both of the switch contacts is/are incorporated into an insulative substrate having a film base on a circuit board panel. The under side of a flexible upper membrane, which overlies the substrate and is spaced apart from the contacts thereon includes a conductive member which may be the other of the switch contacts or a conductive bridge, either of which is adapted to close the contacts upon depression of the flexible membrane.

The problem with tactile or audible feedback membrane switches is that their operation requires a very light force, and a very small deflection in order to complete and close the contact. Thus, without any feedback (i.e., visual, tactile or audible) many operators have difficulty sensing switch closure.

One solution to the problem of tactile feedback or feel has been the introduction of a resilient metal dome which is flexible and which has a certain "snap" when depressed. In use, the marginal edge of the dome is in electrical contact with a first terminal carried by an insulating substrate, while the center of the dome overlies another terminal also carried by the substrate. Upon depression, the central region of the dome contacts the central terminal completing the electrical connection between the two terminals and activating the switch. Upon connection, a simultaneous "snap" is either felt in the surgeon's finger or heard.

Other prior art designs have used an embossed plastic bubble rather than a metal dome which is overlaid on the membrane switch or on a separate layer between the membrane and the overlay. One drawback to the plastic bubble concept is that the plastic bubble often produces undesirable tactile characteristics because it does not uniformly deflect over its entire area. Since the bubble does not deform consistently toward the center, an undesirable "teasing" effect may occur. Switch teasing is undesirable because the operator may receive an acceptable tactile feel response, yet the switch may not close properly or consistently.

Another drawback in the use of the plastic bubble concept is the lack of effective tactile feedback. In other words, it may be difficult to sense (tactically) actual electrical contact with the underlying printed circuit board upon depression of the plastic dome. Moreover, current printed circuit board designs utilize domes having a single plane deposition thickness on the board which further limits overall tactile feedback.

While there have been many attempts to produce suitable and effective electrosurgical devices with finger-operated tactile feedback switches, there exists a need to develop a feedback switch and circuit board arrangement which, when depressed, effectively completes the electrical circuit and provides reliable sensory feedback to the surgeon during use.

SUMMARY

The present disclosure is directed to stepped printed circuit board snap-domes for use in medical devices in order to improve the tactile feedback to a surgeon operating a surgical instrument on which the snap-dome is mounted.

In accordance with one aspect of the present disclosure a tactile switch assembly for use with a surgical instrument includes a substrate, an inner terminal disposed on an upper surface of the substrate and having a first height, an outer terminal disposed on the upper surface of the substrate and substantially surrounding the inner terminal and having a second height which is greater than the height of the inner terminal and a snap-dome secured to the substrate and having a periphery engaged to and in electrical communication with the outer terminal. The snap-dome is depressible through a range wherein, upon inversion of the snap-dome, an apex of the snap dome electrically connect the inner and outer terminals.

Preferably, the snap-dome is connected to the outer terminal at a plurality of contact points. It is envisioned that the outer terminal is substantially ring-like and the outer peripheral edge of the snap-dome is contiguous therewith.

Preferably, the tactile switch assembly further includes an electrosurgical regulator which regulates the amount of electrosurgical energy transmitted upon activation of the tactile switch.

In another aspect of the present disclosure, the tactile switch assembly includes a substrate made of a non-conductive material, a first inner terminal, a second inner terminal and an outer terminal. The first inner terminal is disposed on an upper surface of the substrate and is made from a conductive material defining a first height. The second inner terminal is disposed on the upper surface of the substrate and is internal of the first inner terminal. The second inner terminal is made from a conductive material and defines a second height which is less than the height of the first inner terminal. The outer terminal is disposed on the upper surface of the substrate and substantially surrounds the first inner terminal. The outer terminal is made from a conductive material and defines a third height which is greater than the first height of the first inner terminal.

The tactile switch assembly according to the present aspect of the disclosure further includes a snap-dome secured to the substrate and having a periphery engaged to and in electrical communication with the outer terminal. The snap-dome is depressible through a range wherein, upon depression of the snap-dome, an apex of the snap-dome electrically interconnects the first inner terminal and the outer terminal. Moreover, upon continued depression the apex of the snap-dome electrically interconnects the second inner terminal and the outer terminal.

In yet another aspect there is disclosed a printed circuit board for use with a snap-dome switch of a medical instrument. The printed circuit includes a non-conductive substrate defining an upper surface, a first conductive terminal disposed on the upper surface of the substrate, wherein the first conductive terminal defines a first height, and a second conductive terminal disposed on the upper surface of the substrate, wherein the second conductive terminal defines a second height which is greater than the height of the first conductive terminal. Preferably, the second conductive terminal is generally concentrically spaced from the first conductive terminal.

It is envisioned that the snap-dome is contiguous with the second conductive terminal. Preferably, the snap-dome is depressible through a range wherein upon inversion of the snap-dome an apex of the snap-dome electrically connects the first and second terminals.

In an alternative embodiment, the tactile switch assembly includes a substrate, a plurality of contact pads disposed on an upper surface of the substrate, a turntable rotatably mounted on the upper surface of the substrate, an inner terminal disposed on an upper surface of the turntable, an outer terminal disposed on the upper surface of the substrate and substantially surrounding the inner terminal, the outer terminal having an electrical lead extending therefrom and being electrically contactable with a selected one of the plurality of contact pads and a snap-dome secured to the turntable and having a periphery engaged to and in electrical communication with the outer terminal.

Preferably, the substrate and the turntable are made from non-conductive materials while each contact pad, the inner terminal and the outer terminal are made from conductive materials. Preferably, each contact pad is electrically connected to an electrosurgical energy source.

These and other objects will be more clearly illustrated :below by the description of the drawings and the detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and features of the present invention will become apparent from the following detailed description considered in connection with the accompanied drawings. It should be understood, however, that the drawings are designed for the purpose of illustration only and not as a definition of the limits of the invention.

FIG. **1A** is a side, cross-sectional view of a prior art tactile membrane switch assembly;

FIG. **1B** is a side, cross-sectional view of the tactile membrane switch assembly of FIG. **1A**, shown in the depressed or contact position;

FIG. **2** is a top, perspective view of a printed circuit board in accordance with the present disclosure;

FIG. **3** is a top, plan view of the printed circuit board shown in FIG. **2**;

FIG. **4** is a bottom, plan view of the printed circuit board shown in FIG. **2**;

FIG. **5** is a side, cross-sectional view, of the printed circuit board shown in FIG. **3**;

FIG. **6** is an enlarged, side view of the area in detail of FIG. **5**;

FIG. **7** is a top, perspective view of the printed circuit board of FIG. **2** having a snap-dome mounted to a surface thereof;

FIG. **8** is a side, cross-sectional view of the printed circuit board and snap-dome of FIG. **7**;

FIG. **9** is side, cross-sectional view of the printed circuit board of FIG.**7**, shown with the snap-dome in the depressed or contact position; and

FIG. **10** is a top, plan view of a printed circuit board and snap-dome in accordance with an alternate embodiment of the present disclosure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Preferred embodiments of the presently disclosed stepped printed circuit board for use in connection with snap domes is described in detail herein with reference to the figures wherein like reference numerals identify similar or identical elements.

Referring initially to FIG. **1A**, a tactile membrane switch according to a prior art device assembly is generally identified as switch assembly **10**. Switch assembly **10** includes a substrate of electrically insulating material **12** having layers of non-conductive (dielectric) ink and conductive ink defined thereon which form an electrical circuit **13**. Circuit **13** includes at least one inner contact **24** and at least one outer contact **26**. Preferably, electrical circuit **13** is formed by initially applying a first dielectric layer **14** and subsequently forming additional conductive and dielectric layers in a pattern thereon, e.g., first conductive layer **16**, second dielectric layer **18**, second conductive layer **20** and carbon conductive layer **22**.

A snap dome switch **28** having a predetermined outer perimeter edge **30** is mounted atop switch assembly **10** such that edge **30** connects to outer contact **26**. When the snap dome is depressed, the snap dome completes the electrical circuit between inner contact **24** and outer contact **26**. Preferably, snap dome switch **28** is made of a suitable metal or conductive material and configured so that when depressed, a predetermined range of motion is evident to the surgeon (tactile feedback) through a snap phase of closing the electrical circuit. The surgeon develops a tactile "feel" through the range of motion -and during activation of the switch when depressed and deflected over the center position. Preferably, snap dome switch **28** includes a dielectric outer layer **29** which protects the surgeon from electrical shock during use and reduces the chances of contaminating the switch with surgical fluids.

As shown best in FIGS. **1A** and **1B**, the center area in dielectric layer **18** is typically smaller than the center area of layer **16**, thus allowing the center area of layer **20** to electrically connect to the center layer **16**. Inner and the outer contacts **24** and **26** are disposed atop layer **18** at about the same height to assure consistent electrical contact when the snap dome is depressed to a substantially flat orientation (FIG. **1B**). More particularly, depressing snap dome **28** causes the center of snap dome **28** to snap and engagably contact inner contact **24** which electrically connects inner and outer contacts **24**, **26**, respectively.

FIGS. **2–6** show a stepped printed circuit board **100** in accordance with the present disclosure for use in connection with a snap dome switch. Stepped printed circuit board **100** includes a substrate **102** preferably made from electrically insulating material such as polyester on which layers of dielectric and conductive ink are printed thereon (e.g., screen printed) to define a circuit pattern. It is envisioned that substrate **102** can be fabricated from either a rigid or a flexible insulating material. More particularly and as best seen in FIGS. **2–4**, the layering process preferably forms an outer substantially circular contact terminal **104** and an inner substantially circular contact terminal **106**. Outer terminal **104**.includes an electrical lead **108** which extends through substrate **102** for connection to an electrosurgical energy source and inner terminal **106** includes an electrical lead **110** (see FIG. **4**) which extends through substrate **102** for connection to the same or alternate electrosurgical energy source. While a continuous outer circular terminal and an inner circular terminal has been disclosed herein, other geometric configurations for one or both the inner and outer terminals is envisioned, e.g., arcuate, semicircular, and the like.

Preferably, outer terminal **104** and inner terminal **106** are patterned on substrate **102** by conventional screen printing techniques. Preferably, printed circuit board **100** is constructed using known photo-masking techniques, wherein a photo-mask is applied to the desired dielectric surfaces of substrate **102** and no photo-mask is applied to the desired conductive surfaces of substrate **102**. Accordingly, printed circuit board **100** is constructed by first applying at least one photo-mask to the surface of substrate **102** and covering the areas between outer terminal **104** and inner terminal **106**. After a first layer of conductive material is applied to substrate **102** to form inner terminal **106** and partially form outer terminal **104**, at least one additional photo-mask is applied over substrate **102** to cover inner terminal **106** and the space between outer terminal **104** and inner terminal **106**. Thereafter, at least one additional layer of conductive material is applied to substrate **102**, thereby forming the remainder of the printed circuit board **100**. Other masking techniques are also envisioned for forming the printed circuit board **100**.

As shown, outer terminal **104** is formed by layering a plurality of successive layers of one or more conductive and/or dielectric materials atop one another to define a height "Y1". Inner terminal **106** is also formed by layering a plurality of successive layers of conductive and/or dielectric materials atop one another to define a height "Y2" which is less than height "Y1" (see FIG. **6**). Each layer is applied in registration with the previous layer so as to correctly and accurately define switch sites and conductive runs and appropriately insulate the contacts of each switch site from one another. It is contemplated that outer terminal **104** be made up of five layers of conductive and/or dielectric materials, while inner terminal **106** is made up of two or three layers of conductive and/or dielectric materials. In this manner, as seen best in FIGS. **5** and **6**, the contact surface of inner terminal **106** is recessed relative to the contact surface of outer terminal **104**. For example, outer terminal **104** may include a height "Y1" in a range of about 0.0025 inches to about 0.0075 inches and preferably about 0.0038 inches, while inner terminal **106** may include a height "Y2" in a range of about 0.0005 inches to about 0.0025 inches and preferably about 0.0014 inches. As can be appreciated, arranging the inner and outer terminals in this manner creates a step-like circuit pattern between the inner and outer terminals **106**, **104**.

As best seen in FIGS. **7** and **8**, snap-like tactile feedback member **120**, e.g., snap dome, is mounted to stepped printed circuit board **100** in electrical communication with outer terminal **104** and in vertical registration with inner terminal **106**. More particularly, snap-dome **120** includes an apex **122** and a plurality of feet-like contacts **124** which attach to outer terminal **104**. Preferably, apex **122** and feet **124** are made from electrically conductive material and are in electrical communication with one another. A thin layer of elastomeric/flexible insulating or non-conductive material **126** (see FIG. **8**) coats the outer surface of dome **120** and secures dome **120** to substrate **102**. Feet **124** are located in corresponding space-opposed regions of snap dome **120** and deform downwardly when snap dome **120** is depressed. While a dome **120** having four feet **124** is shown and described, it is contemplated that dome **120** can have any number of feet **124** or can terminate in a continuous terminal edge all the way around. It is further envisioned that snap dome **120** can be any geometric shape other than hemi-spherical as shown in the figures, such as, for example, hemi-cylindrical.

When mounted atop printed circuit board **100**, feet **124** of snap dome **120** are physically and electrically in contact with outer terminal **104** and apex **122** (i.e., the central region of the dome) resides in vertical registration over inner terminal **106**. Upon depression, snap dome **120** deflects downwardly to a point where apex **122** passes the plane of outer terminal **104** and inverts into contact with inner terminal **106**. As can be appreciated, the point of inversion as well as the additional range of travel of the membrane provides an enhanced level of tactile feedback to the user thus enabling the user to more readily ascertain the "active" position of the switch. Moreover, it is envisioned that the snap dome may be dimensioned such that the point of inversion of the snap dome can be coupled with a physical and audible "snap" which can be readily felt or heard by the surgeon thus enhancing the surgeon's control over the activation of the instrument.

More particularly, snap dome **120** is made from a suitable metal or conductive material and configured so that when depressed, true tactile feedback will be sensed by the user when the dome goes through the "snap phase" to close the circuit. As discussed above, the initial tactile "feel" comes from a sudden decrease in force during actuation of apex **122** of snap dome **120** when depressed in the direction "F" over inner terminal **106**. However, in accordance with the stepped printed circuit board **100** design disclosed herein, a second tactile "feel" is apparent when apex **122** passes the horizontal plane defined by outer terminal **104**, i.e., point of inversion. Upon removal of the force "F", the snap dome and membrane **120** return to the original configuration. Thus, according to the present disclosure, an invertable snap-dome, in combination with the novel stepped printed circuit board disclosed herein, greatly enhances the overall tactile feedback to the surgeon. Moreover, the surgeon can more readily "feel" the "on" and "off" positions of the instrument due to the greater range of travel of apex **122** over conventional snap domes wherein the outer and inner terminals reside in approximately the same plane.

The dimensions and configuration of snap dome **120** is crucial in order to ensure consistent repetitive operation thereof. Many factors contribute to the consistent repetitive operation of snap dome **120**, including for example, the material selected, the thickness of the snap dome, the topographical profile of the snap dome, the shape of the dome, the number of feet, the particular arrangement of the feet relative to one another and the overall dimensions (i.e., height of the apex above the printed circuit board, diameter, length, width, etc.).

It is envisioned that snap-dome **120** can be configured and adapted to have more than two-stages as described above. In this manner, the amount of energy being transmitted or the specific operation being performed (i.e., coagulation or cutting) can be selected depending on the position of the apex of the snap-dome. For example, FIG. **9** shows one embodiment wherein the printed circuit board includes two inner terminals **106***a*, **106***b* and which are application specific. More particularly, as apex **122** moves through the range of travel, the outer periphery of apex **122** initially contacts inner terminal **140***a* which transmits a first level of electrosurgical energy to the instrument to coagulate tissue. Further movement of apex **122**, through the range of travel, causes apex **122** to invert and contact a second inner terminal **140***b* which transmits additional electrosurgical energy to the instrument to cut tissue.

It is envisioned that the stepped printed circuit board, in accordance with the present disclosure will be used in connection with surgical equipment and, in particular with electrosurgical equipment. Preferably, the stepped printed circuit boards disclosed herein are sealed within the electrosurgical instrument housing. Moreover, it is envisioned that the one of the terminals, e.g., inner terminal **106**, may be coupled to a switch regulator **140** (FIG. **7**) which allows the surgeon to regulate the amount of electrosurgical energy delivered through the surgical instrument upon activation of the snap dome switch **120**. For example, regulator **140** may include a dial which has predetermined positions which relate to predetermined electrosurgical energy levels for “cutting” or “coagulating” tissue.

Turning now to FIG. **10**, a stepped printed circuit board **200** in accordance with an alternate embodiment of the present disclosure for use in connection with a snap dome switch is shown. Stepped printed circuit board **200** includes a substrate **202**, preferably made from electrically insulating material having a plurality of electrically conductive contact pads **204***a*–**204***d* provided thereon. While four contact pads are shown disposed on substrate **202**, it is envisioned that any number of contact pads can be provided. Each contact pad **204***a*–**204***d* includes a respective electrical lead **206***a*–**206***d* which extends through substrate **202** for connection to an electrosurgical energy source. It is envisioned that each contact pad **204***a*–**204***d* results in the activation of a different electrosurgical function, such as for example, cutting, coagulating, sealing, etc.

Printed circuit board **200** further includes a turntable **208** rotatably coupled thereto. Turntable **208** is preferably circular and is defined by a terminal edge **210**. While a circular turntable **208** is preferred, turntables having other geometric configurations, such as, for example, triangular, square, rectangular, polygonal and the like are envisioned. Turntable **208** is preferably made from an electrically insulating material and includes an electrically conductive outer terminal **212** disposed thereon having an electrical lead **214** extending radially outwardly therefrom. Preferably, electrical lead **214** extends through turntable **208** to electrically contact a respective one of the plurality of contact pads **204***a*–**204***d* of substrate **202**. Accordingly, as turntable **208** is rotated, electrical lead **214** of turntable **208** is selectively brought into electrical contact with one of the plurality of contact pads **204***a*–**204***d* of substrate **202**. While a single electrical lead **214** is shown, it is envisioned that any number of electrical leads can be provided. It is further envisioned that turntable **208** is slidably mounted to substrate **202** in order to activate various other contacts and the like.

Printed circuit board **200** further includes an electrically conductive inner terminal **216** disposed thereon. Similar to printed circuit board **100**, inner terminal **216** is disposed within outer terminal **212**. Preferably, inner terminal **216** has a height which is less than a height of outer terminal **212**. Inner terminal **216** includes an electrical lead **218** which extends through substrate **202** for connection to the same or an alternate electrosurgical energy source. Printed circuit board **200** is constructed in such a manner that as turntable **208** rotates atop substrate **202** an electrical connection is maintained between inner terminal **216** and electrical lead **218**.

A snap-like tactile feedback member **220** (i.e., snap dome **220**), similar to snap dome **120** described above, is mounted atop turntable **208**. Snap dome **220** is preferably in electrical communication with outer terminal **212** and in vertical registration with inner terminal **218**. Preferably, snap dome **220** includes an apex **222** and a plurality of feet-like contacts **224** which attach to outer terminal **212**. When mounted atop turntable **208**, feet **224** of snap dome **220** are physically and electrically in contact with outer terminal **212** and apex **222** resides in vertical registration over inner terminal **216**.

In use, the surgeon rotates turntable **208** in either a clockwise or a counter clockwise direction, as indicated by double headed arrow “A”, in order to select a desired function of an electrosurgical instrument to which printed circuit board **200** is mounted. By rotating turntable **208**, the surgeon effectively aligns and established an electrical connection between electrical lead **214** of turntable **208** and a selected one of the plurality of contact pads **204***a*–**204***d*. Accordingly, alignment of electrical lead **214** with a selected one of the plurality of contact pads **204***a*–**204***d* results in selection of an alternate electrosurgical function (i.e., cutting, coagulating, sealing, etc.). As such, the surgeon can select the function desired directly from the electrosurgical unit.

It is envisioned that indicia (not shown) can be provided on the outer surface of snap dome **220** and radially aligned with electrical lead **214** of turntable **208** in order to provide the surgeon with a visual indication as to the position of electrical lead **214**. It is further envisioned that separate identifying indicia can be provided in the vicinity of each of the plurality of contact pads **204***a*–**204***d* in order to provide the surgeon with an indication as to what function snap dome **220** has been rotated to.

It is contemplated that turntable **208** and substrate **202** are configured and adapted such that turntable **208** “snaps” into a selected position (i.e., a position in which electrical lead **214** is aligned with a selected one of the plurality of contact pads **204***a*–**204***b*) as the surgeon rotates turntable **208**. For example, substrate **202** can be provided with a plurality of recesses (not shown), corresponding to each of the contact pads **204***a*–**204***d*, formed in the surface thereof while turntable **208** includes a projection (not shown), configured and adapted to be received within a selected one of the plurality of recesses, extending from a bottom surface thereof. In use, as turntable **208** is rotated, the projection travels from recess to recess. Moreover, the projection/recess combination provides the surgeon with a tactile feel as to the when turntable **208** is in a selected position.

While embodiments of stepped printed circuit boards according to the present disclosure have been described herein it is not intended that the disclosure be limited thereto and the above description should be construed as merely exemplifications of preferred embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the present disclosure.

What is claimed is:

1. A tactile switch assembly for use with a surgical instrument, comprising:

a substrate made of a non-conductive material;

an inner terminal disposed on the upper surface of the substrate, the inner terminal being made from a conductive material and having a first height from the upper surface;

an outer terminal disposed on the upper surface of the substrate and substantially surrounding the inner terminal, the outer terminal being made from a conductive material and having a second height from the upper surface of the substrate, the second height being greater than the height of the inner terminal; and

a snap-dome secured to the substrate and having a periphery engaged to and in electrical communication with the outer terminal, the snap-dome being depressible through a range wherein, upon inversion of the snap-dome, an apex of the snap-dome electrically connects the inner and outer terminals.

2. The tactile switch assembly according to claim **1**, wherein the periphery of the snap-dome defines a plurality of discrete contact points extending therefrom, wherein the snap-dome is in electrical communication with the outer terminal via the plurality of discrete contact points.

3. The tactile switch assembly according to claim **2**, wherein the outer terminal is substantially ring-like and the outer peripheral edge of the snap-dome is contiguous therewith.

4. The tactile switch assembly according to claim **1**, further comprising an electrosurgical regulator electrically connected to the inner terminal, the electrosurgical regulator being configured and adapted to regulate the amount of electrosurgical energy transmitted upon activation of the tactile switch.

5. A tactile switch assembly for use with a surgical instrument, comprising:

a substrate made of a non-conductive material;

a first inner terminal disposed on an upper surface of the substrate, the first inner terminal being made from a conductive material and having a first height;

a second inner terminal disposed on the upper surface of the substrate and internal of the first inner terminal, the second inner terminal being made from a conductive material and having a second height which is less than the height of the first inner terminal;

an outer terminal disposed on the upper surface of the substrate and substantially surrounding the first inner terminal, the outer terminal being made from a conductive material and having a third height which is greater than the first height of the first inner terminal; and

a snap-dome secured to the substrate and having a periphery engaged to and in electrical communication with the outer terminal, the snap-dome being depressible through a range wherein, upon depression of the snap-dome, an apex of the snap-dome electrically interconnects the first inner terminal and the outer terminal and upon continued depression the apex of the snap-dome electrically interconnects the second inner terminal and the outer terminal.

6. A printed circuit board for use with a snap-dome switch of a medical instrument, the printed circuit board comprising:

a non-conductive substrate defining an upper surface;

a first conductive terminal disposed on the upper surface of the substrate, the first conductive terminal defining a first height from the upper surface; and

a second conductive terminal disposed on the upper surface of the substrate, the second conductive terminal defining a second height from the upper surface, the second height being greater than the height of the first conductive terminal, the second conductive terminal being generally concentrically spaced from the first conductive terminal.

7. The printed circuit board according to claim **6**, wherein the snap-dome is contiguous with the second conductive terminal.

8. The printed circuit board according to claim **7**, wherein the snap-dome is depressible through a range wherein upon inversion of the snap-dome an apex of the snap-dome electrically connects the first and second terminals.

9. A tactile switch assembly for use with an electrosurgical instrument, comprising:

a substrate made from a non-conductive material;

a plurality of contact pads disposed on an upper surface of the substrate, each contact pad being electrically connected to an electrosurgical energy source;

a turntable made from a non-conductive material, the turntable being rotatably mounted on the upper surface of the substrate;

an inner terminal disposed on an upper surface of the turntable, the inner terminal being made from a conductive material;

an outer terminal disposed on the upper surface of the turntable and substantially surrounding the inner terminal, the outer terminal having an electrical lead extending therefrom and being electrically contactable with a selected one of the plurality of contact pads upon rotation of the turntable; and

a snap-dome secured to the turntable and having a periphery engaged with and in electrical communication with the outer terminal.

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